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ABSTRACT

This exploratory study was designed to investigate the explanatory and predictive power of the transaction between affect and cognition in the account of transitions across developmental stages within various domains. Subjects were 21 undergraduate college students from a course on intellectual development taught at Tufts University (Massachusetts). Students were told to select some domain, such as juggling, photography, tennis, or chess; to study it for the term; and to reflect on their learning process during the semester. Data were obtained through weekly progress questionnaires completed by each subject after he or she had completed each lesson. Subjects rated their level of performance and assessed their feelings about their progress and overall level of ability. In addition, subjects completed a preliminary background questionnaire that covered their "metahobby" choice and expectations for progress. Subjects' teachers were asked to rate their students' level of ability at the beginning, middle, and end of term. Findings supported the notion that a person systematically experiences various emotions when learning the skills necessary to move from novice status toward mastery status. An overall mixture of emotions was generally experienced at moderate levels of ability, while more pronounced exclusivity of positively and negatively valenced emotions occurred at higher levels of performance. Subjects who thought they would progress far did so. (RH)

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Affective Signatures: Emotional Concomitants of Developmental Change

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Thought itself is engendered by motivation, i.e., by our desires and needs, our interests and emotions. Behind every thought there is an affective-volitional tendency which holds the answer to the last "why" in the analysis of thinking. A true and full understanding of another's thought is possible only when we understand its affective-volitional basis.

- Vygotsky, 1962 p.150

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Any full account of development must eventually include explanations for the mechanisms by which that development takes place. One such mechanism that seems ripe for investigation is the transaction between affect and cognition. This study was designed to investigate the explanatory and predictive power of such transactions in the account of developmental transition within various domains. Motivational factors, both intrinsic and socially mediated, provide the energizing factor left out of most accounts of how human beings process information. Yet, casual introspection and anecdotal accounts suggest that different emotions are experienced as one progresses through the different skill levels within a domain, moving from novice toward expert mastery.

Although the transaction between affect and cognition has received relatively little empirical attention, there is some work which gives credence to this idea that particular emotions accompany different aspects of cognitive performance. For example, research in the area of effectance motivation (e.g. Harter, 1975, 1978) has found that feelings of pleasure accompany successful interaction with a domain.

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Affective Factors in Cognitive Transitions

The traditional Piagetian account of the impetus for universal cognitive reorganization, centered around the imbalance of assimilatory and accommodational activities (Piaget, 1971), ostensibly obviates the need to further explicate motivational or affective factors. Piaget's later emphasis on reflective abstraction as a transition mechanism (Piaget, 1981a), while a clarification and refinement of developmental process still does not directly address the issue of motivation. Piaget spoke but briefly and in general terms to the affective component of cognitive development, saying that affect and cognition were two sides of the same coin (Piaget, 1981b) and noting structural similarities between the two constructs (Piaget, 1973).

In general Piaget saw affect as having an energizing role in development, but this was not his main interest and so went relatively unexplored. Some Piagetian and neoPiagetian researchers have moved to rectify this omission (e.g.

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Cowan, 1982; Decarie, 1978) and attempts have been made to adapt the Piagetian framework for clinical ends (e.g. Greenspan, 1979; Wolff, 1960) but most of these accounts have been hampered by attempting to fit the new notions into the rigidly cognitively-biased Piagetian framework (but see Case, et al, 1985).

In recent years an increasing amount of attention has been given to the developmental aspects of affect (Sroufe, 1979; Izard, 1978). Some concern has also been paid to the interface of affectivity and cognition (see Cichetti & Hesse, 1982 for a review). To date, however, the actual role of affect in development has received relatively scant empirical notice.

One aspect of the transaction of cognition and affect which has been investigated is the relation between pleasure and cognitive mastery (Deci, 1975; Harter, 1975; Harter, Shultz, & Blum, 1971). These investigators have reported that children will persist at challenging tasks for the reward of simply finding the solutions to them. Harter (1978), furthermore, has reported that this relationship is not a simple and linear one. She reported that subjects seemed to find an optimal level of challenge in the anagram task they were asked to solve: when a more difficult level was added to the task, subjects' smiling became attenuated, suggesting that a curvilinear relationship (an inverted "U") between pleasure and mastery might be most descriptive. Additionally, an even more pronounced inverted U relationship was found between perceived difficulty of anagram tasks and smiling (Harter, 1978). This suggests that there is not only a push to mastery for competence but also a preference for optimally challenging tasks. Tasks that are too easy or too difficult are not as pleasing. Other research has shown that the affective response often occurs at the presentation of the problem and may influence the kind of strategy the individual chooses for working on a solution and also the amount of energy to be expended on it (Salomon, 1982; Siegel, Goldsmith, & Madson, 1982). These findings indicate that the processes by which individuals solve problems are complex and suggest that there is some sort of reciprocity between the mastery attempts and the affective and cognitive experiences.

Intuitively it seems reasonable to expect that emotions other than pleasure may be experienced during problem solving. It has been shown that people experience a mixture of emotions during most emotional times (Diener & Iran-Nejad, 1986). Their research suggests that only at extremely high levels of either positive or negative affect is there an exclusion of the oppositely valenced emotions. These results suggest that it may be necessary to look at both positive and negative emotions and to examine these emotions at different points in any particular developmental process.

Additional research by Yarrow and his colleagues has indirectly addressed the question of the possible catalytic effects of affective forces on changing thought structures (Yarrow, Rubenstein, & Pederson, 1975; Yarrow, et al 1983; Yarrow, et al, 1984). They have found that mastery behavior in infants is influenced by developmental level, underlying children's earliest attempts at exploration and efforts to get feedback from the environment.

The idea that emotion and cognition are positively correlated has been put forth by a number of researchers (Dudek, 1972; Dudek & Dyer, 1972; Goldschmid, 1968). The affect accompanying a transaction with the environment can plausibly be considered an outcome of the relative success or failure of that transaction, and a reinforcer for the maintenance or attenuation of

subsequent like behavior. Langer, for example, has argued for affect as a critical ingredient of structural cognitive change (Langer, 1969). More recently Feldman (1980a) has suggested that individuals in the process of intellectual change experience a series of affective reactions which parallel his proposed phases for developmental transitions.

Current Research

In the current research, Feldman's model of a transition cycle is used as the backdrop for studying the role of affect in developmental transition (Feldman, 1980b). Feldman's premise is that transition cycles will proceed in a functionally similar manner across all domains of knowledge that are developmental. The six phases he has described are assumed to hold for transitions between levels in any developmental domain, and should, conceptually, also engage similar affects, regardless of the domain being mastered. Positing affect as one of the internal factor vectors that influences cognitive change allows for a more complete description of transition mechanisms and hence a better ability to predict and guide development.

This study investigates transition from level to level in non-universal developmental domains by charting the progress of university students as they begin lessons in a new field of endeavor. This technique has been used more informally as an instructional method for getting students to reflect first hand on the kinds of cognitive changes described in developmental theory (Feldman, 1980a). Students are required to take weekly lessons in a field which they would like to learn and to keep a journal in which they reflect on their own experiences in beginning to master this domain. Feldman has called this exercise "metahobby" because of the emphasis on students' metacognitive reflection and understanding of their own process of beginning to master a new domain.

In the present study, this "metahobby" experience was structured more formally, with students making weekly ratings of their ability in a number of specific skills, and also rating their feelings about their progress. The students were also asked to make weekly lists of the specific skills being taught and practiced in their lessons.

Because this study was primarily exploratory, it was guided by a set of preliminary questions rather than formal hypotheses:

1. What do transitions look like in different domains?

2. Can emotional concomitants to changes in developmental level be empirically found?

3. How are reported affect states related to each other, both globally and specifically?

4. What are the relationships between the perceived difficulty of a domain, and subjects' levels of competence and performance?

5. What are the relationships between the perceived difficulty, competence, weekly performance and subjects' feelings about their ability

and progress?

Method

Subjects

Subjects were 21 undergraduate college students from an Intellectual Development course at Tufts University. Participation in the research study was voluntary, although all students in the class were required to participate in some form of a metahobby assignment. The class assignment was to select some domain to study for the term, and to reflect on their own learning process during the course of the semesters' lessons. Usually students select lessons in some domain that has been of interest to them, but which they have never taken the time to learn--e.g., juggling, photography, tennis, chess. Students must arrange for weekly, formal instruction, and keep a detailed journal where they attempt to analyze their own process of beginning to learn the domain.

Questionnaires

The data from this study came from weekly progress questionnaires completed by each subject after they completed each lesson. These questionnaires included subject ratings (on 8-point Likert scales) of their level of performance that week on a number of designated skill areas. Subjects also completed 8-point rating scales of 18 adjectives designed to assess their feelings about their progress and overall level of ability (for the listing of these affects, see Table 2). In addition to these weekly progress questionnaires, at the beginning to the study subjects completed a preliminary background questionnaire which included general information about metahobby choice and their expectations for their progress during the semester. In addition, subjects' teachers were given questionnaires and asked to rate their students' level of ability at the beginning of the term, and their progress at mid-term and the end of the term.

Results

Emotions Experienced During Mastery

Overall, subjects most often felt positively about their progress during the course of the semester (e.g., high ratings of: Challenged, Interested and Enthusiastic), and least often felt negatively (low ratings of Angry, Resistant and Confused). In general, overall positive and overall negative affect varied inversely. Since the literature suggests that global, two-dimensional analyses have been more powerful than analyses that attempt to look at more specific emotions (Diener & Iran-Nejad, 1986), 14 of the 18 affects rated were divided into positive and negative groups, as noted above, for further analyses. Pearson correlations revealed that those designated "positive" and those designated "negative" were all positively correlated within those groups at moderate but statistically significant levels and generally negatively correlated between groups at moderate but statistically significant levels. The affective

mixture reported in this study supports other researchers' observations that positive and negative emotions are mutually exclusive only at high levels of intensity (see Table 1). Overall, the mean for the positive affects was 2.83, with a mean of 2.30 for negative affect. Direction of affect was computed by subtracting negative affect from positive affect. For all subjects over all sessions affective valence was in a positive direction 125 times, in a negative direction 59 times, and equal (positive = negative) on only 14 occasions.

Cognitions During Mastery

Subjects rated themselves as novices at the beginning of the semester (mean rating= 0.55, with a range from 0 to 2 on an 8-point scale.) On average subjects reported that they expected to progress to an intermediate level of ability (from level 0 to level 4). Those subjects who expected to progress farther did so, at least in their own judgment: expected progress was positively correlated with actual overall progress (level of ability at last session minus level of ability at first session) r =.42, p = .003.

The perception of one's competence at a given lesson was positively correlated with the positive emotions of Comfortable, Confident, and Proud and was negatively correlated with their ratings of Challenged, Excited, Frustrated, and Unsure (see Table 2). The anomaly here would seem to be the negative correlation between judgments of competence and their ratings of feeling Excited. If subjects interpreted the adjective Excited as connoting general arousal, then an increase in ability would bring with it an increase in confidence (as it seemed to do in these subjects) and less of a need to become more aroused.

Subjects' difficulty rating of the lessons was positively correlated with their ratings of Challenged, Frustrated, Uneasy, Confused, Unsure, Anxious, Angry, Interested, Compliant, Enthused, Excited, and Resistant. Difficulty was negatively correlated with Confident (see Table 2). That level of difficulty was positively correlated with emotions that are both positively and negatively valenced indicates that there is no simple linear relationship between difficulty level of task and affect. A graphing of the relationship between Difficulty and global positive affect, for example, shows results consistent with the inverted "U" found by Harter (1975), although the full downward drop with increasing difficulty was not obtained in this study, presumably because the degree of difficulty never approached the highest levels experienced by Harter's subjects (see Figure 1). This figure also clearly shows different relationships between difficulty and positive and negative affect, respectively. In contrast to the curvilinear relationship between difficulty and positive affect, there is a definite linear rise in negative affect as difficulty level increases.

Direction of affect tended to be positive when the difficulty level was high, supporting the idea that an optimal level of difficulty is motivating (X^2 = 55.57 (df = 4) $p \leq .001$). Direction of affect was either positive or negative when one's performance was low, but when performance was high, direction of affect was positive (X^2 = 58.62 (df = 4) $p \leq .001$).

Transitions

This study covered the greater part of one college semester. This is not enough time for most subjects to make significant progress in mastering their metahobbies. Additionally, sophisticated task analyses of the levels involved in shifting from novice to expert have not been done in very many domains. This makes fine-grained level diagnosis difficult, particularly in non-universal domains which, as a group, have not been the concern of developmentalists. With these limitations in mind, the 8 rated levels of skill performance were collapsed into 4 levels. Shifts were then designated whenever: the mode shifted in either direction; the mode remained the same but the bias shifted directions; or when the mode remained the same but the number of skills clustering at the mode changed by at least two skill elements. Using these criteria, 85 level shifts were identified in 17 subjects, for an average of 5 shifts per subject, and a range of 2 - 11. Forty-eight forward shifts were noted and each subject had at least 1 such shift. Thirty-seven reversal shifts were identified in 15 cases. Fifteen subjects had both forward and reversal shifts and none had only reversals. Fifteen reversals immediately following a forward move were found as were 12 forward shifts immediately following a reversal.

Crosstabulations revealed that direction of affect was positive when level shifts were forward and negative during shift reversals. Similarly positive affect was greater when level shifts were forward and less during reversals. Though these findings were in the expected direction, of the four analyses only those of the reversals were statistically significant. Even this must be viewed as only suggestive since chi-squares were computed on data that were not independent.

Comparisons of global positive and global negative affect during forward and reverse shifts indicated that positive affect is higher for a forward shift and negative affect is higher for a reverse shift (see Table 3). Again, the data are not independent and generalizations are not appropriate. However, the directionality of the means is consistent with other findings.

Discussion

This study explored the nature of novices' affective experience as they begin to master non-universal, developmental domains. Cognitions pertaining to ability, performance and the difficulty of the tasks were examined in relation to the rated emotions. The relationships among those cognitions were studied, and an effort was made to identify the relationship between level to level transitions and affective state.

Affective States

The idea that one systematically experiences various emotions when learning the skills necessary to move from being a novice towards mastery of a domain was supported. In general positive emotions were experienced at higher intensities than negative emotions. High positive affect was attached to engaging in an undertaking felt to be enjoyable.

There is neither an exhaustive list nor a clustering technique for discrete emotions agreed upon by researchers in the area of affective development. Diener and Iran-Nejad (1986) did find that emotions of like valence tend to co-occur. The emotions chosen as positive and negative in the present study did correlate positively with each other at moderate but statistically significant levels. The fact that the correlations were not extremely high would appear to indicate that the emotions did indeed lie on the same plane but were not merely synonymous.

Previous research (Diener & Iran-Nejad, 1986) indicated that positive and negative emotions are mutually exclusive only at high levels of intensity. Additionally, the co-occurrence of hedonically similar emotions is stronger than the inverse occurrence of oppositely valenced emotions. These findings were confirmed in the current study. An overall mixture of emotions is generally experienced at moderate levels, while there is much more exclusivity of positively and negatively valenced emotions at the high levels. In spite of the overall mixture at most levels an inverse relationship between the individual positive and negative emotions does obtain, but is not exceedingly strong. This indicates that affective constellations are complex rather than simple processes.

Cognitions

Subjects' perceptions of their competence, specific performances, and the level of task difficulty at each session were assumed to be important both as motivators of and reactions to actual performance and affective experience. In this formulation neither cognition or affect is seen as prepotent to the other, rather they are seen as recursively interacting aspects of the developmental process.

The subjects saw themselves as novices, and though they all studied different specific domains, each subjects started out with some relatively unfamiliar body of knowledge to master. Those subjects who thought they would progress farther did, in fact, do so. Perhaps this was a function of a superior ability to more realistically gauge themselves and/or the domain, perhaps it is a function of cognitive style. Future research might examine more closely the relation of expectation to attributions following success or failure.

There has been relatively little attention in the literature to the function of negative affects in cognitive activity. This study suggests that, during the course of early mastery of a new cognitive domain, negative affects are felt more keenly and more frequently than are positive ones. We would speculate that the intensity of negative emotions seemed to be largely related to subjects' expectations for their progress. Since they counted on improving as their lessons proceeded, subjects were pleased but not ecstatic when they felt that they were, indeed, progressing: their positive affect was moderate. When, however, they perceived no progress, or even regression of ability (both of which violated their expectations), their emotional reactions were much stronger. These negative feelings may also serve an energizing function, helping to direct and focus the individual's energy and attention back to the task of developing new abilities.

Feelings of comfort, confidence, and pride accompanied high ratings of ability; feelings of challenge, frustration, unsureness, and excitement went along with low ability. These relationships are all readily intuitive, save the negative

correlation of excitement with ability. Perhaps, if ability is high then there is no need for a higher level of arousal to perform well, confidence and comfort are high and proficiency suffices.

Harter (1974, 1978) has reported that there is a curvilinear relationship between perceived difficulty and manifest pleasure. In the present study level of perceived difficulty was examined in relation to specific affects. Statistically significant relationships were found between difficulty and emotions of both positive and negative hedonic valence. The inverted U was demonstrated when "Pleased" was used as the dependent variable. Negative affect increased as difficulty level increased. These findings suggest that difficulty has a differential effect on global positive and global negative affect.

Further study is needed to clarify the role of these two global affects, both as motivators and actual orchestrators of cognitive change. The current study suggests that positive and negative affect may represent two separate, but most often co-occurring, systems that interact differently in cognitive processing.

Table 1

Frequency Count of Combinations of Positive and Negative Affect

Level of negative affect	Level of positive affect				
	1	2	3	4	5
1	2	1	1	1	0
2	3	8	9	18	4
3	2	20	29	14	0
4	4	22	21	4	0
5	2	21	5	0	0

Table 2

Competence, Difficulty, Performance by Individual Emotions

	Cognition		
Emotion	Ability	Difficulty	Performance
Ambivalent	-.09 NS	-.02 NS	-.16 *
Angry	.03 NS	.27 ***	-.21 **
Anxious	-.04 NS	.29 ***	-.02 NS
Challenged	-.19 **	.48 ***	.28 ***
Comfortable	.24 ***	-.02 NS	.61 ***
Compliant	.01 NS	.22 **	.19 **
Confident	.26 ***	-.16 *	.57 ***
Confused	-.11 NS	.35 ***	-.26 ***
Content	.08 NS	.02 NS	.70 ***
Enthused	-.09 NS	.17 **	.55 ***
Excited	-.17 *	.13 *	.50 ***
Frustrated	-.17 *	.41 ***	-.30 ***
Interested	-.10 NS	.22 ***	.55 ***
Pleased	.10 NS	-.02 NS	.69 ***
Proud	.15 *	.04 NS	.69 ***
Resistant	-.00 NS	.13 *	-.25 ***
Uneasy	-.09 NS	.39 ***	-.26 ***
Unsure	-.20 **	.33 ***	-.27 ***

NS Not Significant, * $p < .05$; ** $p < .01$; *** $p < .001$

Table 3

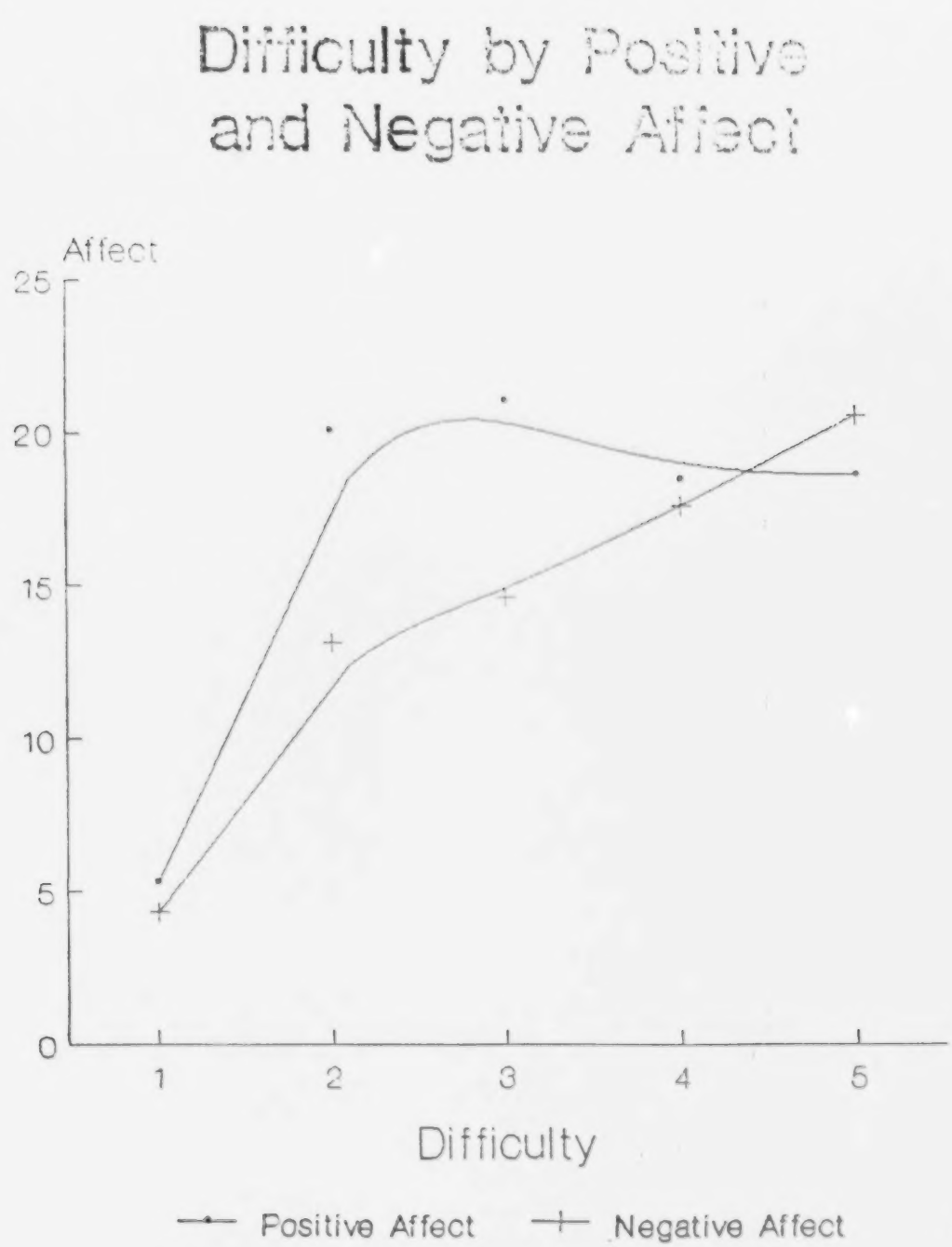
Direction of Affect by Level Shifts

	Level Shifts	
Direction of Affect	Forward	Reverse
Up	24	11
Down	18	24
	X^2 = 0.857 (df=1)	X^2 = 4.829 (df=1)
	p = 0.36	p = 0.028

Positive Affect x Level Shifts

	Level Shifts	
Positive Affect	Forward	Reverse
Up	22	11
Down	20	25
	X^2 = 0.095 (1)	X^2 = 5.44 (1)
	p = 0.28	p = 0.02

Figure 1



Mean Global Positive and Negative Affect at each Level of Difficulty